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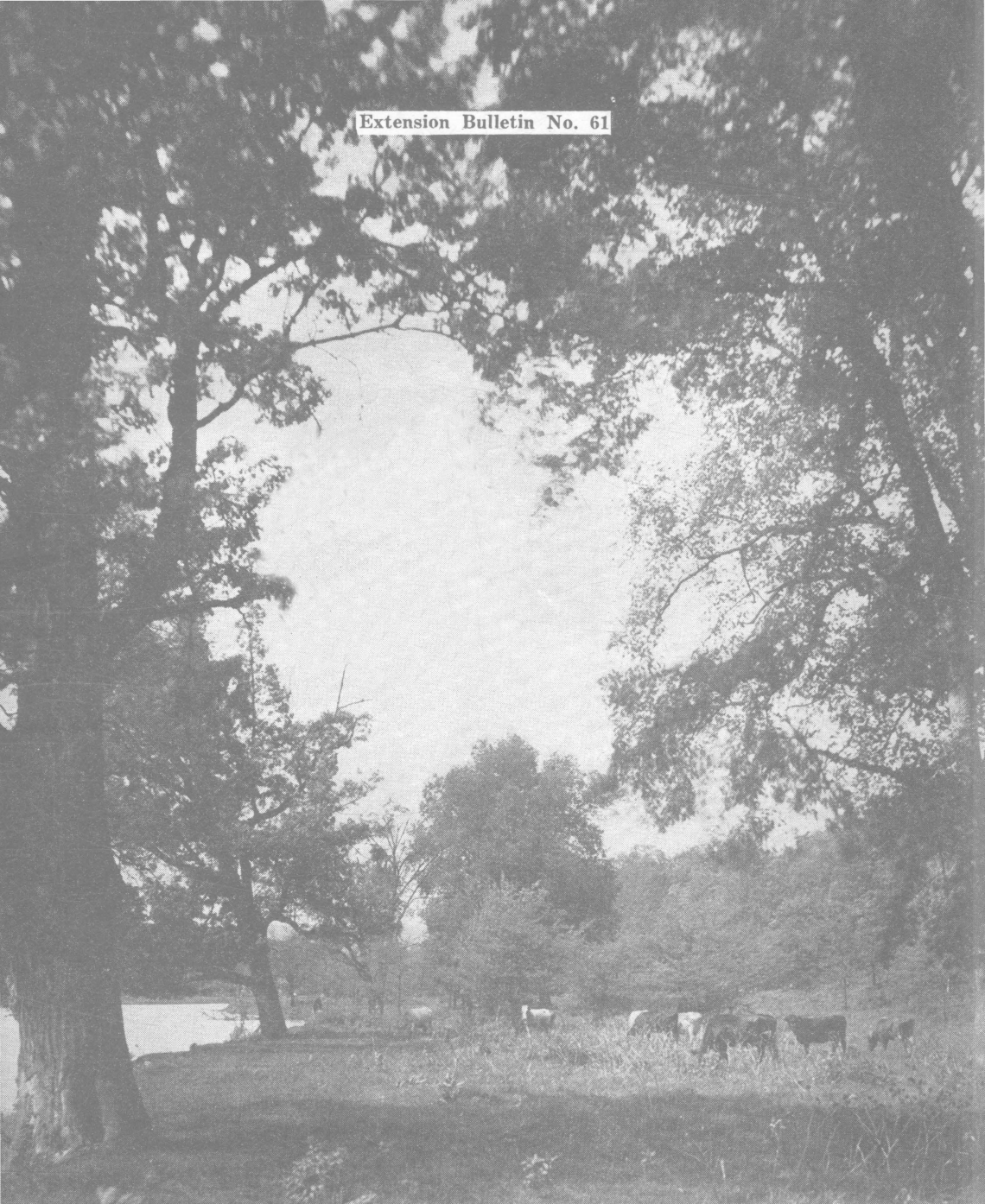


Permanent Pastures

By

M. V. Bailey

Specialist in Crops and Soils, The Ohio State University

THE VOICE OF THE GRASS

Here I come creeping, creeping everywhere;
By the dusty roadside,
On the sunny hillside,
Close by the noisy brook,
In every shady nook,
I come creeping, creeping everywhere.

Here I come creeping, creeping everywhere;
You cannot see me coming,
Nor hear my low sweet humming;
For in the starry night,
And the glad morning light,
I come quietly creeping everywhere.

Here I come creeping, creeping everywhere;
More welcome than the flowers
In summer's pleasant hours;
The gentle cow is glad,
And the merry bird not sad,
To see me creeping, creeping everywhere.

Here I come creeping, creeping everywhere;
My humble song of praise
Most joyfully I raise
To Him at whose command
I beautify the land,
Creeping, silently creeping everywhere.

SARAH ROBERTS BOYLE (1812-1869)

The Ohio State University, Cooperating with the United States Department of Agriculture.
AGRICULTURAL EXTENSION SERVICE, H. C. RAMSOWER, Director, Columbus
FREE—Cooperative Agricultural Extension Work—Acts of May 8 and June 30, 1914

PERMANENT PASTURES

By M. V. BAILEY
Specialist in Crops and Soils

The term "permanent pastures" commonly includes all the land that is left in pasture year after year for a long time. If it is plowed up once in four or five years it can scarcely be included with the permanent pasture land.

Permanent pasture land in Ohio includes a great variety of land, such as level, undulating, rolling, steep, overflow, stony, and practically all of the important soil types found in the state. However, on a great majority of Ohio farms such pastures are confined

Fig. 1.—Permanent pasture land, Muskingum silt loam, Scioto County. *Too steep for cultivation.*

to the land too rough and hilly for easy cultivation (see Fig. 1) and to the creek bottoms which overflow.

This, no doubt, is as it should be, for there are many rolling and hilly fields which under cultivation erode badly, but which produce excellent pasture.

On the other hand, there are many thousands of acres of hilly land (see Fig. 2) in pasture that should have been left in forest. Erosion has started on these and reforestation (see Fig. 3) is the only practical means of stopping it. Between 55 and 60 per cent of the now so-called permanent pasture land in Ohio is of this type and should be returned to forests, as the cost of liming and fertilizing makes pasture production prohibitive. It can, however,

Fig. 2.—Reforestation is the only means of redeeming this eroded Hocking County pasture.

be reforested with very slight expense. Where there are some trees already growing or where there is a good natural seeding of forest trees, it is very detrimental to the growing of the trees to pasture it. Under such conditions the amount of pasture produced is almost negligible.

Fig. 3.—Locust trees successfully stopped erosion in this Ross County pasture.

Fertility Problems in Connection with Permanent Pastures

Many Ohio Pastures Are Not Productive.—That many thousands of acres in Ohio now supposed to be in permanent pasture are not producing efficiently is evidenced by the fact that 4.2 acres

Fig. 4 —Map showing number of acres of pasture per unit of livestock.

are kept in pasture for the maintenance of each livestock unit (one mature cow or steer, two young cattle, or ten fine wool sheep).

The number of acres of pasture per unit (cattle and sheep only considered) of livestock in each county is given on the above map of the state, Fig. 4.

It is quite evident from this map that if only eastern and southern Ohio were considered the average pasture acreage for each

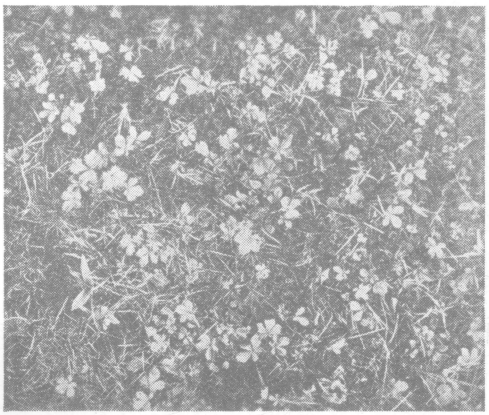


Fig. 5.—Typical pasture growth on a poor pasture—cinquefoil, poverty grass, and moss.

livestock unit would be considerably larger than 4.2 acres. A visit to the pastures of western Ohio and then to some of those in eastern Ohio shows clearly why more acreage is required in the latter part of the state. In place of the white clover and Kentucky bluegrass, which are commonly considered the best permanent pasture crops, many eastern Ohio pastures are growing mosses of various kinds; cinquefoil (Potentilla canadensis); broom sedge (Andropogon virginicus); yarrow (Achillea millefolium); poverty grass (Danthonia spikata); running briars (Rubus procumbens); oxeye daisy (Chrysanthemum leucanthemum), and bracted plantain (Plantago aristata), (see Fig. 5), with only a very little bluegrass and clover mixed in with it.

Almost all pastures in Ohio were at one time in good bluegrass and clover. The change to these very undesirable and unpalatable weeds and grasses has come about in the last 50 years or so. The cause of the change is a matter of speculation, because the common opinion held by many people has been that to pasture land is to rest it, and therefore a permanent pasture should gradually increase in fertility. The change in vegetation which has come about is an indication of a decrease rather than an increase in fertility. It is a well established fact that bluegrass and clover thrive best on fertile soils and such are ordinarily those which contain relatively large amounts of phosphorus and limestone. The soil in the famous bluegrass region in Kentucky averages about 21,000 pounds of phosphoric acid per acre, 8000 pounds of which is considered available, while that in Ohio averages about 2520 pounds, with that of eastern Ohio averaging only about 1800 pounds. This Kentucky soil also contains considerable amounts of limestone, while eastern Ohio soils are, as a rule, acid.

The difference in the soils explains the difference in the vegetation. While the Ohio soils never did contain as much limestone and phosphorus as those mentioned in Kentucky, they did at one time contain larger amounts than are now present.

The Phosphorus has been Sold.—Many acres of this pasture land have never been cultivated, and no crops have been removed. The manure produced by the livestock grazing on the land has not been removed. The question is, therefore, why do these soils contain less phosphorus and limestone than they did when first cleared from forest and put in pasture?

It is true that about 75 per cent of the phosphorus of the feed of livestock is excreted in the manure, but the other 25 per cent is retained in the livestock body or excreted in milk. This long continued removal of the 25 per cent of the phosphorus contained in the feed through the sale of livestock and livestock products has finally depleted the supply of phosphorus, which was not very high in the beginning, to a point where it is a limiting factor in the growth of desirable pasture crops.

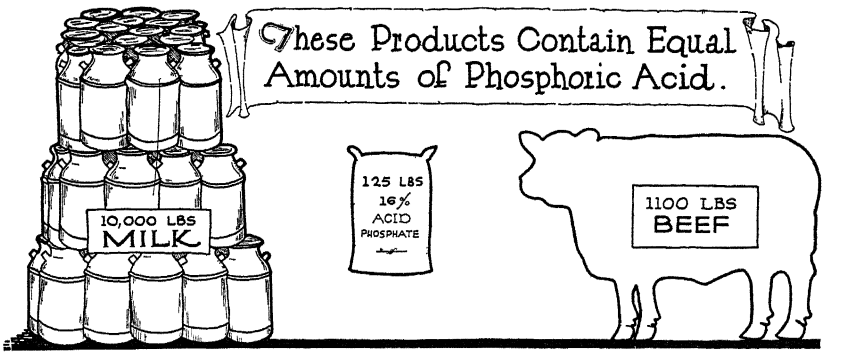


Fig 6—Phosphorus is being sold continually from the farm.

When 10,000 pounds of milk is sold, the phosphorus it removes from the farm is equivalent to that contained in a 125-pound bag of 16 per cent acid phosphate (see Fig. 6). The phosphorus contained in 1100 pounds of live weight of livestock is equivalent to that contained in 125 pounds of 16 per cent acid phosphate. Considering the fact that many pastures in Ohio have been in constant use for from 50 to 100 years, it is not surprising that the supply of available phosphorus is getting low.

The Lime that has Leached Out.—The lime that is in the soil is subject to a continual loss through leaching out in the drainage water. The rapidity with which it leaches out varies with the amount in the soil, the amount of rainfall, the soil texture, and the kind of covering on the soil. The loss in Ohio ranges from 300 to 500 pounds per acre per year. An analysis of the water in

the Muskingum River indicates that the lime is being removed from the land drained by that river at the rate of 360 pounds per acre per year. In addition to this, small amounts are removed by livestock and livestock products.

Desirable Plants are Dependent on Lime and Phosphorus.—When lime and phosphorus become low in a soil the clovers are unable to compete with the undesirable grasses and weeds for a place in the flora. Bluegrass in pastures is very dependent on a supply of nitrogen for successful growth. This supply is furnished largely by the clovers present, so it is evident that when the clover begins to fail, because of a lack of phosphorus and lime, the bluegrass also begins to fail, because of a lack of nitrogen.

Seventy-five years' work on grass lands in England has shown that the use of nitrogen fertilizers alone has encouraged the growth of the shallow rooted grasses to the exclusion of practically all legumes, whereas the liberal use of mineral fertilizers has caused legumes to make up more than one-half the vegetation.

Proof of the fact that the growth of grasses is largely regulated by the nitrates present in the soil is also found in any orchard that receives annual applications of nitrate fertilizer. Such a practice always results in a luxuriant growth of grasses, such as bluegrass and timothy, to the exclusion of legumes, as shown in Fig. 7.

The explanation of the cycle between white clover and bluegrass apparently lies in the dependency of bluegrass on available nitrogen. The clover grows thickly for a year or two, and in so doing builds up the nitrogen supply in the soil. When this supply becomes high enough the bluegrass thickens up and crowds the clover, until the nitrogen becomes low again and the clover crowds the bluegrass.

How and When to Supply the Phosphorus.—The deficiency in phosphorus caused by long continued pasturing can most economically be replenished by an application of acid phosphate, basic slag, or some other good carrier of phosphorus. The amount needed to start the growth of white clover varies somewhat according to the extent of the fertility depletion, but as a general average at least 400 pounds of 20 per cent acid phosphate or its equivalent should be used per acre. This may be applied with a drill on top of the present sod at any time that it is convenient to perform the labor, except when the ground is covered with snow and ice or when it is very wet. Late summer and fall applications are very satisfactory, since the work can be done then with a minimum amount of effort on the part of the farmer. Spring applications are

just as satisfactory as far as results are concerned, but unless the material is applied very early in the spring it is very doubtful if any results will be seen the first season. Summer and fall applications, of course, show no apparent results until the following summer.

Just how long the initial application of acid phosphate will suffice is still a matter of some conjecture, as there is little experimental evidence to guide one in answering this question. The experience of farmers in Ohio who have treated pasture land indi-

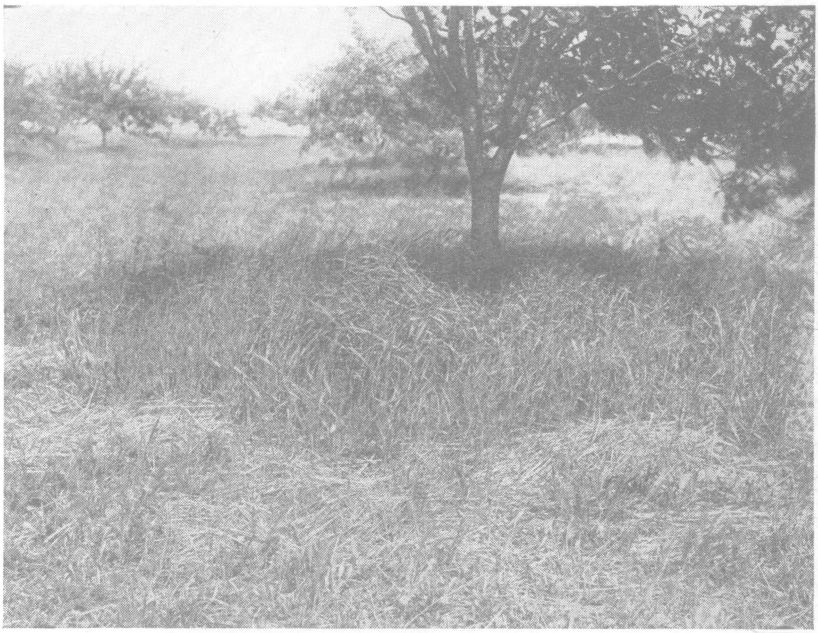


Fig. 7.—Effect of nitrates on bringing in bluegrass and timothy.

cates that such a treatment on average pasture land will produce good pasture for at least seven or eight years. At the end of this time another application should be made. There are many pastures in Ohio from which so much fertility has been removed that the treatment would need to be repeated in four years. Land of this kind is of very low value for pasture or for production of any other crop.

How to Meet the Need for Lime.—When soils lose their limestone they become acid or sour, and the growth of clovers is unsatisfactory. There is no practical way of remedying this condition

except by the addition of some sort of liming material. Either agricultural ground limestone or hydrated lime will supply the need and give satisfactory results if applied in proper amounts. About 1400 to 1500 pounds of good hydrated lime is equivalent in neutralizing power to a ton of average agricultural ground limestone as sold in Ohio. Whichever of these materials can be delivered to the farm the cheaper is the one that should be bought.

Since the amount of acidity in soils is quite variable there is no definite amount of lime recommended. The soil should be tested and its lime requirement determined. Investigations of the pasture improvement work in Ohio indicates that enough lime should be added to bring the *p*H value up to 5.5. (*p*H value refers to the intensity of acidity that is in the soil. If a soil is neutral its *p*H value is 7.0; if it is acid its *p*H value is less than 7.0. When lime is added to the soil the *p*H value is raised.)

The lime should be applied in the same manner as the phosphate and may be applied at any time that is satisfactory for a fertilizer application. Because of road conditions, late summer and fall applications are often the most desirable.

If, at the outset, enough lime is added to bring the *p*H value up to 5.5 the application need not be repeated for at least seven or eight years, when another ton per acre should be applied.

How about Manure?—Many pastures have been improved by manure applications, but this method of improvement is not recommended because the manure brings a greater return per ton if it is applied to the cultivated land where it benefits a crop of much higher money value per acre than pasture. However, if enough manure is produced on the farm to cover all the cultivated land once each rotation of three or four years and there still remains a surplus, it is satisfactory to apply it to pasture land.

Another objection to manuring pastures is that because of its relatively high content of nitrogen and low content of phosphorus it produces a growth of the grasses to the exclusion of the clovers, giving a poorly balanced pasture growth. Ordinarily, farm manure carries a plentiful supply of weed seeds which germinate in pastures with annoying regularity.

Pasture Management

Use and Abuse of Pastures.—The general use of a pasture is as important as is the fertility treatment. Perhaps the most common mistake in this regard is that of putting livestock out on pastures too early in the spring. Before pasturing in the spring the soil should be well settled and dry so as to prevent damage by the livestock packing the soil. The grass and clover should be permitted to get a good growth before it is pastured too closely. If once eaten off very closely early in the spring, it seldom completely recovers that season, and is less able to withstand the usual dry weather of the summer months.

Once the pasture has gotten a good growth there is still danger of putting too much livestock on it. The famous pastures of England require a little more than an acre to support one mature cow or steer (1 animal unit) through a season. Ohio pastures have to be very good if two acres will support a mature cow or steer throughout a pasture season. Enough livestock should be kept on pasture to eat the material as it is produced, but it should not be pastured so closely that the growth of the vegetation is stunted.

Weed Control.—This is largely a fertility problem. Weeds usually become troublesome in pastures when the conditions are not favorable to the growth of desirable plants. On the other hand, when conditions are kept favorable for the growth of bluegrass and white clover, the weeds are seldom a serious problem.

In addition to the pasture treatment of lime and fertilizer as recommended, it is very important that the weeds be kept mowed off to prevent seed formation. This is especially important in the case of annual weeds which come from seed each year. In the case of the perennial weeds the continued mowing stunts the growth and gives the desirable plants a better opportunity to compete with them.

The thin pastures that are well covered with weeds should be mowed at least twice during the season.

Cultivation Not an Essential.—It has been successfully demonstrated in Ohio that permanent pastures can be rejuvenated without cultivation. In several cases thorough disking has been resorted to at the time of fertilizer and lime applications, but the results obtained were not of enough extra value to pay for the labor involved. In fact, in many cases the results with cultivation have not been as satisfactory as without it. Because of the nature of most pasture land, plowing is out of the question, and disking is

the only choice left for cultivation. If this is done thoroughly it destroys about all the vegetation on the pasture and the new sod has to come from seed, which is very expensive.

If there is no cultivation the improvement comes about by the spreading out by vegetative reproduction of the desirable plants

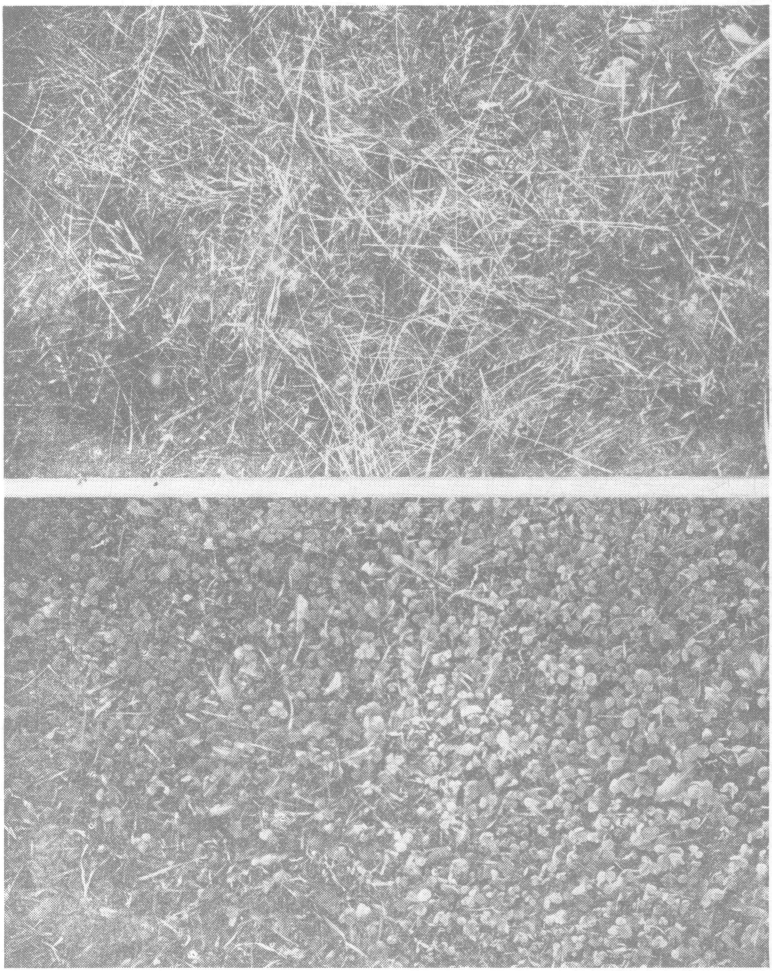


Fig. 8.—White clover will thrive if properly nourished. Upper picture shows a Trumbull County pasture before treatment; lower picture shows same pasture after treatment.

already in the old sod but which have been very inconspicuous because of soil acidity and lack of fertility (see Fig. 8). Once supplied with lime and fertilizer these small starved plants make a good new sod more quickly than one can be secured from seed.

Such a sod is secured without cultivation and seeding expense and the attendant dangers of erosion. A white clover sod secured without cultivation is shown in Fig. 8.

Seeding an Old Pasture.—Only in exceptional cases is reseeding recommended, because, as stated, the most rapid improvement comes about through the spreading out of the desirable plants already in the pasture. Good seed mixtures are expensive and should be resorted to only in case there are practically no desirable plants of any size in the sod. If, on close examination, an average of only one small white clover plant per square yard is found, no seeding is necessary.

In case seeding is necessary, the following mixture is recommended per acre:

2 pounds of white clover
2 pounds of redtop (recleaned seed)
2 pounds of alsike clover

Establishing a Permanent Pasture

Many infertile hill fields now in cultivation which erode easily should be put in permanent pasture. If such a field has been in meadow some time, there is likely to be some clover and bluegrass in it. The treatment recommended for improving permanent pastures should give satisfactory results under these conditions. However, if the field has recently been cultivated, the most satisfactory way to get it into pasture is to plow it and seed it with a pasture mixture and a nurse crop. A light seeding of oats to be cut for hay makes an excellent nurse crop. The seed mixture to be used might vary a little, depending on the location in the state. The following mixtures have been found to be satisfactory:

Southeastern Ohio:

White clover	1½–2	lbs
Mammoth clover	3–4	"
Timothy	4	"
Kentucky bluegrass	4–5	"
Japan clover	5–6	"
Redtop (recleaned)	3	"
Orchard grass	6–8	"

Northeastern Ohio:

Kentucky bluegrass	4–5	lbs.
Timothy	4	"
Alsike	2–3	"
White clover	1½–2	"
Orchard grass	6–8	"

Southwestern Ohio:

White clover	1½–2	lbs.
Sweet clover	6	"
Mammoth clover	3–4	"
Kentucky bluegrass	4–5	"
Timothy	4	"

Northwestern Ohio:

White clover	1½–2	lbs.
Sweet clover	6	"
Alsike clover	2–3	"
Kentucky bluegrass	4–5	"
Timothy	4	"

The land should be tested for acidity, the lime requirement met, and at least 400 pounds per acre of a fertilizer high in phosphoric acid applied with the nurse crop.

The above seed mixtures may be used with wheat as a nurse crop. In case the wheat was not heavily fertilized when seeded, it should receive some additional fertilizer at the time of sowing the pasture mixture. A 2-16-2 fertilizer would be very satisfactory for this.

Japan Clover.—Japan clover, or Lespedeza, is gradually spreading northward in the permanent pastures in Ohio, having come in from West Virginia and Kentucky. It is a common annual

Fig. 9.—Lime and phosphoric acid caused the increase in growth of Japan clover (right) in this Meigs County pasture.

clover of the south, where each year's stand always comes up from seed. It is not definitely known just how far north it will mature seed. Since it is an annual, this is an important point, as it scarcely makes a large enough growth to make it profitable to seed it each year.

Plants have been known to reseed themselves as far north as Coshocton County, but many farmers report failure to reseed in Jefferson, Harrison, Licking, and Perry Counties. In all of the Ohio River counties from Washington County down the river it grows luxuriantly, and is rapidly spreading over all the permanent pastures. Seeding it is recommended in all counties south of the latitude of Fairfield County.

It should be seeded in early or mid-winter by broadcasting on the old sod. Four pounds of seed per acre is sufficient; this will give a light stand which, if it is going to thrive in the pasture, will the first year produce enough seed to seed the area heavily. If it is not going to thrive in any particular location, an extremely heavy seeding as is sometimes recommended will not help the situation.

Recent studies in some 20 counties indicate that the average pasture soil in eastern Ohio is not acid enough to prevent growth,

Untreated Treated

Fig. 10.—A heavy application of lime made the growth of sweet clover possible in this Athens County pasture.

but the addition of some lime and phosphorus greatly increases the yield (see Fig. 9). Growth does not come on until late in the season and furnishes little pasture before August 1, but from that time on it produces good grazing on extremely thin acid soils even in exceedingly dry weather.

Sweet Clover.—Sweet clover, as a pasture crop, is of greatest value in rotated rather than permanent pastures. Under right conditions no doubt it produces a larger amount of pasture per acre than any other crop grown in Ohio, but as a general rule, it requires at least one more ton of ground limestone per acre to grow

sweet clover than it does to grow red or white clover. The addition of this ton of limestone to the cost of the treatment necessary for white clover and bluegrass makes the cost almost prohibitive in many cases. However, where the lime requirement of the soil is not high or where large amounts of pasture are needed at any cost, sweet clover has its place in permanent pastures and can be grown (see Fig. 10). When used it should be sown in late winter or extremely early spring.

Fig. 11.—Scioto County hills that are suited only to forestry.

In a permanent pasture, sweet clover, like the clovers of lower lime requirements, is only a stepping stone to bluegrass sod, because it gathers the all important nitrogen for the bluegrass, as was explained before. As soon as any of the clovers increase the nitrogen content to a certain level, bluegrass comes in and seriously competes with the clover. Sweet clover, because of its ability rapidly to increase the nitrogen content of the soil, is soon crowded out by bluegrass; it is only a matter of a few years until the same sort of a pasture prevails as would have occurred had white clover been encouraged.

Some Results of Pasture Treatment

Improvement of Pastures in England.—In 1897, William Somerville, working in England, began definitely measuring the increase resulting from treatment of permanent pastures. Small areas of poor pastures were treated with lime and different carriers of phosphorus, potash, and nitrogen, in varying amounts and combinations. All applications were made on top of the old sod without any cultivation or seeding.

The results of the different treatments were determined by weighing and analyzing the herbage produced and by measuring the amount of mutton produced per acre per season. Where only phosphatic fertilizers were used a very close correlation was found between the pounds of protein produced per acre and the pounds of mutton produced.

Some of the practical conclusions drawn from this work are as follows:

1. Lime used alone with heavy applications (4 tons per acre) proved very ineffective, but smaller applications with phosphorus have sometimes been justified.

2. Phosphate applied as single heavy dressings (1000 pounds per acre) generally proved most effective in improving feeding value of pasture, and its effects were not nearly exhausted at the end of nine years.

3. It has proved more profitable to apply a heavy dose of basic slag as a single dressing than to divide it in two equal portions and apply these with a three-year interval. However, repeated dressings of basic slag had a marked effect in some cases, and the productiveness of slagged pastures that were showing signs of exhaustion was rapidly improved in this way. The action of a repeated dressing appears to be more rapid in many ways than the action of the first dose.

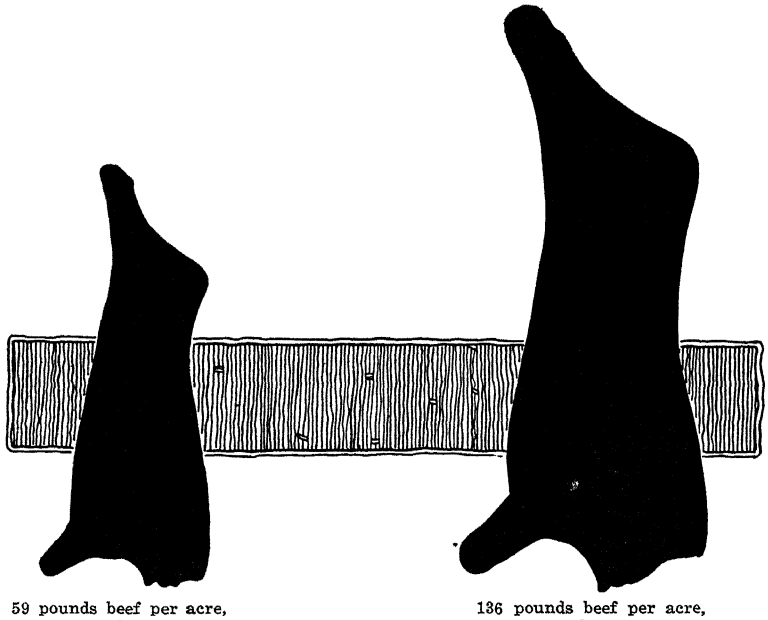
4. Potash added to a phosphate application generally resulted in an increase in live weight produced, but the increase was not a profitable one.

5. The addition of moderate dressings of sulfate of ammonia or nitrate of soda to land already phosphated increased the yield of herbage, but as a rule decreased the yield of mutton. This was, no doubt, due to the stimulation of growth of grasses at the expense of clovers, which decreased the amount of protein produced.

Improvement of Southern Ohio Pastures.—In the spring of 1924, 10 acres in a 36-acre Muskingum silt loam hillside pasture received 3000 pounds of ground limestone and 400 pounds of acid

phosphate per acre. Both materials were applied on the old sod without any cultivation or seeding. The whole pasture, both treated and untreated parts, was pastured to capacity that same season.

In the spring of 1925 the treated 10 acres were fenced off from the 24 acres of untreated pasture and both parts were pastured to capacity from May 9, 1925, to November 4, 1925. The treated part produced 136 pounds of beef per acre and the untreated part produced only 59 pounds of beef per acre (see Fig. 12).



59 pounds beef per acre, untreated pasture

136 pounds beef per acre, treated pasture

Fig. 12.—Amounts of beef produced per acre of Scioto County pasture May 9, 1925, to November 4, 1925.

Improvement of Southeastern Ohio Pastures.—Through the use of small cages on treated and untreated pastures in Guernsey, Hocking, Jackson, and Perry Counties, Earl E. Barnes of the Ohio State University measured the actual differences in yield resulting from limestone and acid phosphate treatments in one, two, and three years after the treatment. In all these pastures studied, small plots with representative soil, pasture flora, and location were left untreated. Therefore, the difference in the vegetation produced in the two cages in the same pasture was caused entirely by the treatment. Three of these pastures received some tillage and seed; the fourth received no seed or tillage. Judging, however, by the results obtained on hundreds of other pastures treated since

this work, we feel safe in saying that the seeding or tillage had little influence on the results except in one case where sweet clover was sown. On part of them the seeding was the same on the unfertilized as on the fertilized plots.

The immediate effect of the treatment was a marked increase in the percentage of legumes. This was later followed by a renewal of bluegrass sod, which does not reach its optimum until at least the end of the fourth summer after treatment.

The vegetation produced on the treated portions of these pasture fields was at the rate of from three to five times as much per

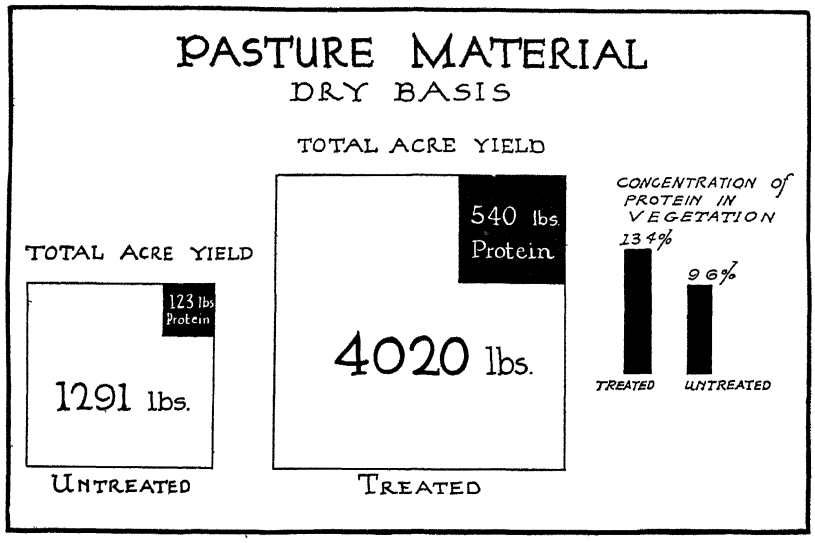


Fig. 13.—Pasture growth on treated land is more valuable because of the increased protein production.

acre as was produced on the untreated portions of these fields, except in one case where the sod was injured by moles.

The relative amount of crude protein produced per acre was from five to seven times as much on the treated as on the untreated portions of these fields (see Fig. 13).

After making a chemical analysis of the vegetation produced, Mr. Barnes concludes: "The greatest difference in chemical composition between vegetation produced on treated and untreated portions of the same field is found to be in the percentage of nitrogen.

"The percentage increase in the content of calcium in the vegetation as a result of an acid phosphate and limestone treatment is greater than the percentage increase in its content of phosphorus."

SUMMARY

1. Permanent pastures in Ohio are largely confined to land that is not suitable for cultivated crops, but is too valuable for forestry purposes.
2. The extremely rough and badly eroded lands should be reforested or left in forests.
3. As an average over the state, 4.2 acres of permanent pasture are required to maintain a mature cow or steer (one animal unit) throughout the pasture season. The carrying capacity of eastern Ohio pastures is not nearly as high as that of western Ohio pastures.
4. The carrying capacity of Ohio pastures is becoming less and less, because the original bluegrass and white clover sods are being replaced by a growth of moss, weeds, and briars which have low feeding value and exceedingly small yield.
5. This change in the type of vegetation is taking place because of the loss of lime and phosphorus from the soil.
6. The original supply of phosphorus is being gradually sold off the farm in livestock and livestock products.
7. The original supply of lime is being gradually lost through leaching.
8. The soil should be supplied with phosphorus by making liberal applications of commercial carriers of phosphoric acid, such as acid phosphate or basic slag.
9. The need for lime should be met with applications of liming materials. The amount needed per acre should be determined by testing the soil.
10. Applications of manure usually improve a pasture but the practice is not recommended, because the manure can be more profitably used on cultivated crops. Manure usually introduces troublesome weeds in a pasture.
11. Permanent pastures can be materially improved without any cultivation.
12. The seeding of old pastures is, in most cases, unnecessary.
13. Good pasture management requires that the livestock be kept off it in the spring until a good growth is started, and that it be not pastured too heavily throughout the summer.
14. Weed control is largely a fertility problem. If a pasture is weedy it should be mowed at least twice during a season.
15. Good permanent pastures may be established in cultivated fields by cultivation, seeding, fertilizing, and liming.
16. Japan clover produces desirable late summer pasture in only a limited area in the southeastern part of the state. If the season is long enough it produces seed on very thin, acid soils, but it responds liberally to fertilizer and lime applications.
17. Sweet clover produces large amounts of pasture but, if the soil is acid, it requires at least a ton more of ground limestone per acre than do other legumes.
18. Regardless of the legume started in a pasture, bluegrass soon comes in and crowds it very much.
19. Pasture improvement is brought about by the increased production of protein which is directly reflected in livestock and livestock products.